BUREAU OF SUGAR EXPERIMENT STATIONS
BRISBANE

THE CANE GROWERS' QUARTERLY BULLETIN

ISSUED BY DIRECTION OF THE
HON. F. W. BULCOCK, MINISTER
FOR AGRICULTURE AND STOCK

1 APRIL, 1934

DAVID WHYTE, ACTING GOVERNMENT PRINTER, BRISBANE

CONTENTS.

	PAGE.
*The Soil Population, by H. W. Kerr	111
An Effective Cane Beetle Trap, by E. Jarvis	117
The Value of Irrigation in Mackay	120
The Selection of Disease-free Cane Plants, by W. Cottrell-Dormer	121
*Trash Conservation, by N. J. King	126
Fiji Disease Outbreak	132
Concession Freight Rates	132
History of the Queensland Sugar Industry	132
*Some Factors Influencing the Sugar Content of Cane, by H. W. Kerr	133
*Some Notes on the Soils of the North Queensland Cane Areas, by G. Bates	139

*Reprinted by courtesy of the Queensland Society of Sugar Cane Technologists.

The
Cane Growers' Quarterly
—Bulletin—

VOL. I | 1 APRIL, 1934 | No. 4

The Soil Population.

By H. W. KERR.

A CAREFUL examination of a Queensland cane soil immediately reveals its essentially mineral character. It would be found on analysis that at least 90 per cent. of the dry mass of any such soil consists of disintegrated and decomposed rock minerals, while in most cases this proportion would rise to 95 per cent. However, were a soil nothing more than the altered remains of some ancient rock, it would be quite worthless agriculturally. Such a lifeless, inert mass is entirely incapable of supporting crop growth, and we find that the fertility of the soil is intimately associated with that small residue—some 5 or 10 per cent.—which is not of mineral but of organic origin.

From the earliest times this fact has been appreciated by agriculturists. The earliest writings of which we have record stress the necessity for working into the land farmyard manure or other decomposing crop residues in order to increase its fertility. However, the true function and behaviour of these materials in the soil presented a problem the solution of which was discovered only in very recent times. It was in 1877 that two famous French chemists first demonstrated the manner in which nitrogen is made available to the crop in the form of nitrate; they proved conclusively that this process is effected by a select group of minute organisms which inhabit the soil, and their researches provided the stimulus for a most intensive study of similar reactions which take place in the soil. In the short space of the ten years 1880 to 1890, many new facts were brought to light, which demonstrated most convincingly that the soil possesses its peculiar population of minute organisms; and the work of more recent times has provided us with a clearer picture of their life processes, and the important part they play in soil fertility and crop nutrition. It is the purpose of this paper to trace briefly the manner in which these organisms obtain and consume their food, and the nature of the by-products of their work. Doubtless this subject provides one of the most fascinating chapters of the romance of the soil; and it is one of much greater importance to the agriculturist than is generally supposed.

THE SOIL BACTERIA.

When one speaks of bacteria or fungi, the lay mind immediately conjures up visions of dread diseases of man, beast, or plant, in their many and sinister forms. Yet the number of micro-organisms responsible for visitations of this nature constitutes, fortunately, a very small minority; and by far the greater number of "microbes," as they are popularly known, are the friends of man; they are ever busy in his service, destroying the waste remains of animal and plant life, and without whose aid the earth would be so littered with the corpses and plant remains of bygone centuries that life as we know it would be quite impossible. The soil is the native habitat of these helpful types. To give some idea of their widespread nature and the immensity of their number, it may be stated that a teaspoonful of rich garden loam contains as many as 100,000,000 of bacteria! Yet each is so minute that when magnified 1,000 times it appears only as a small sphere or rod which is just clearly discernible, and the myriads of these tiny forms of life to be found in an acre of such a soil would weigh a mere 50 lb.

The soil bacteria have been the subject of intensive study for the past fifty years, and it is now known that they are extremely varied both in detailed form and in the nature of the work which they perform. It should be stated, from the outset, that we are not at all interested in their individual shapes or sizes, or in the bewildering names under which they labour. We are interested only in their work, and the relationship of this work to the soil and crop. Suffice it to say that the bacteria constitute the simplest forms of life. Whereas the "bodies" of the higher plants and animals are built up of numerous tissues, each composed of its many individual cells, the bacterium is a "single-cell" individual. That is to say, this organism, composed of one simple cell, is able to perform the essential functions of life for which the tissues and organs of higher forms of life are so specialised. Reproduction is effected by the simple expedient first of elongation of the cell, after which it divides in the centre to produce two individuals. The speed with which bacteria may thus increase in numbers, under favourable conditions, is truly amazing. The entire process of cell division, as it is called, may occupy only a brief half hour, so that if the process were repeated over a period of fifteen hours, it is possible for a single cell to give rise to 1,000,000,000 individuals! It will be evident that natural conditions never allow such excessive multiplication; but this calculation demonstrates how the numbers of active individuals may grow when food supply and other growth conditions are suitable.

FOOD SUPPLY.

It is a difficult matter to decide whether bacteria should be regarded as plants or animals; they possess habits which might cause them to be placed in either category, but they are usually regarded as resembling rather the plant kingdom. We will, therefore, look upon each bacterium as a minute plant, and study its life functions in some detail. Like the higher plants, they must have food for their growth and reproduction; but whereas green plants are able to manufacture their own foods—

that is, sugars, starches, proteins, and so on—bacteria are entirely dependent on an outside source for their needs. It is in this respect that we find them of special interest, for they derive their food from the plant and animal residues which find their way to the soil, and it is this process of "decay" or decomposition which we should clearly understand, if we would appreciate the true benefits derived from the work of the soil population.

Now, these plant and animal remains are decidedly complex in their make-up. As the bacterium possesses no internal digestive system, how is it able to deal with the substances contained in the organic matter? Obviously, the food must be brought into solution before it can be absorbed through the delicate cell-wall which surrounds the organism. In point of fact, this is accomplished by the secretion of special "digestive juices" which are able to attack and dissolve the organic matter. Furthermore, all groups of bacteria are not capable of dealing with the same classes of substances, just as we find that the higher animals, for example, are specialised in their food requirements.

DECOMPOSITION OF GREEN MANURE AND TRASH.

As regards the simple sugars—which are readily soluble in water—we find that they are suitable sources of food for almost all types; but as the composition of the organic substances becomes more and more complex, the specialised behaviour of the respective groups of micro-organisms becomes more clearly defined. These facts have a most important bearing on the mode of organic decay in the soil, and to illustrate the point let us consider the decomposition of, firstly, a crop of legumes, and secondly, of a mass of cane trash ploughed into the land. If the green manure crop be turned under when in a succulent condition, it presents a most favourable source of food. The sugars in which it abounds are eagerly devoured by the many soil organisms; the starches and proteins which constitute the bulk of the remainder offer but little resistance to decomposition and the soil population undergoes rapid multiplication due to the favourable food conditions presented. As a consequence, the heavy mass of green matter almost completely disappears in the course of three or four weeks; the only visible remains are the relatively small amounts of woody stems which offer stouter resistance to decomposition, but they eventually break down also under the persistent attack of specialised groups of organisms.

Consider now what happens when a mass of dry trash is ploughed under. This material is notably deficient in the readily "digested" sugars and starches, and is composed to a great extent of the more complex and resistant compounds, whose decay is far less complete, over a given period. There is another point of dissimilarity between these two sources of bacterial food. Like all plants, the bacteria demand a supply of available nutrients (or *plantfoods* as they are often called), if they are to grow and function successfully. As far as possible the bacteria derive their nutrients from the organic matter on which they feed, and with the succulent bean or pea crop they are abundantly provided for in this respect. Trash, on the other hand, is far from

favourable, and it must be regarded as a highly "unbalanced" food; naturally, then, the bacteria must seek elsewhere in order to make up the deficit in plantfoods, and they turn to the available supply of the soil. It is usually found that nitrogen and phosphate are in greatest demand, which explains why an application of these nutrients in the available condition (for example, as sulphate of ammonia and superphosphate) effects a marked stimulus in the speed of rotting of a compost heap of moist trash.

It is evident that the trash decomposition will thus result in a temporary depletion of the soil's nutrient supply, and this provides a ready explanation of the oft-experienced fact that the ploughing under of a mass of cane crop residues induces most unfavourable growth conditions for our economic crop, while the rotting is in progress. Eventually, however, the nutrients absorbed in the process, together with those contained in the trash originally, become available once again for crop nutrition; but the temporary evil effects may be most serious, when, for example, the trash from a crop of plant cane is ploughed under at ratooning time. The practice is a bad one, particularly in dry areas, as the rotting process also depletes the soil moisture supply. It is much better to put the trash to good use in the form of a soil mulch, to complete a measure of its rotting on the land surface during the wet season; and when the ratoon stubble is eventually ploughed out, the process is completed in the soil while the land is in fallow. That a green manure crop ploughed under at this time speeds up the rate of decomposition, is explained by the fact that the legume provides an abundance of available nitrogen for the bacteria which perform the work.

It is thus evident that the nature of the reactions which the soil bacteria carry out depends to a very large extent on the nature of their food supply. But in any case, the net effect of their labours is to reduce plant and animal remains to the simplest state. The end products are largely carbonic acid gas and water, while in the decomposition process the soil nutrients such as nitrogen, phosphate, lime, and potash, are again released and made available for crop nutrition. This in itself is a most commendable service which should earn for the soil population the lasting gratitude of the agriculturist. But there is a further aspect to this process of decay which is of even greater importance in that it confers more lasting benefits on the land.

SOIL HUMUS.

It was stated that most plant and animal tissues eventually succumb to the sustained attack of the "digestive juices" secreted by one or another group of soil bacteria. It should now be added that one peculiar class of plant substance is, however, able to withstand this onslaught in a large measure, and emerges from the attack with but slight modification to its original state. These interesting substances are known as *lignins*, and they constitute a large proportion of the "woody" parts of plants. As the result of the operations of the soil organisms, the original identity of these tissues is definitely altered, and they emerge as dark-coloured compounds, collectively and popularly known

as *humus*. It is scarcely necessary to stress the value of this compound, and its influence on the chemical and physical properties of the soil. It is this substance which is largely responsible for that favourable granular soil structure so characteristic of a rich garden loam; it exercises a profound influence on the moisture-holding capacity of the soil, and confers on the land a marked degree of drought resistance. Whereas a sandy soil is capable of retaining about one-sixth of its weight of moisture, humus is able to hold twice its weight of water. A soil rich in humus does not pack readily in times of heavy rainfall, and a subsequent light cultivation usually suffices to restore it once more to a condition of good tilth. It possesses the power of holding large amounts of plantfoods in a readily available state, in addition to the fact that practically the *entire* nitrogen supply of the soil is a constituent part of the humus*, from which condition it is made available to our economic crop, through the process of slow decomposition effected by the soil bacteria. It is for this reason that a mass of decayed rock minerals cannot support plant life—it is totally devoid of nitrogen, an essential plantfood material.

When the above properties of humus are carefully reviewed, there is no agriculturist who would not agree that this is far and away the most important soil constituent; and it is particularly unfortunate that our Queensland cane soils are extremely deficient in this compound. The reason is not difficult to determine. Our coastal areas are notable for their uniformly high temperature conditions, together with an abundant rainfall. This combination of factors entirely favours the rapid and complete decomposition of organic matter in the soil. Moreover, high annual rainfall also promotes a rapid removal of plantfoods, one of which in particular—that is, *lime*—is of very great importance in fixing the humus in the soil. When this nutrient is lacking, the humus is freely carried away in the drainage waters. This is amply demonstrated by the brown-coloured waters so commonly observed in many of the creeks and swamps of our poorer coastal forest lands.

Under these conditions it is evident that the problem of maintaining the organic matter content of the soil is a serious one, and is associated in no small measure with the rapid decline in fertility which so commonly follows the breaking up of our cane lands. The process of intensive cultivation which accompanies cane production is most favourable in its influence on the rapid depletion of humus. The growing crop profits from the latter process, but it is effected at great expense to the land. It has been stressed repeatedly that green manuring once in four years cannot be expected to contribute markedly to the permanent supply of soil organic matter, valuable though the practice is from other standpoints. The rapid and relatively complete decomposition of a succulent leguminous crop results in the production of but little humus, owing to the low proportion of lignins in its makeup. The only substances available to the cane grower to help him in his difficulty are the residues of the cane crop itself—that is, the oft-abused tops and trash which, in a wet harvesting season at least, are regarded simply as an unmitigated nuisance. The slow and incomplete decay of this material in the soil is a distinct advantage in this respect, and owing

* Strictly speaking, this statement applies to the entire organic matter supply of the soil, and not alone to the more specific class of compound defined above as *humus*.

to its relatively high lignin content, a reasonable proportion of humus results. Even the consistent conservation of all available trash over a period of, say, twenty years, however, cannot be expected to enrich the soil permanently to the extent of more than 1 or 2 per cent. of humus. But what an improvement this would effect on many of our run-down soils!

OTHER SOIL ORGANISMS.

So much, then, for a brief and totally inadequate description of the economy and life work of certain of the soil bacteria. Nothing has been said of those specialised forms whose duty it is to convert ammonia to nitrates; or of those busy little organisms which are able to abstract the nitrogen gas from the atmosphere, and build it up into forms of nitrogenous compounds which ultimately become available for crop nutrition; or of the species which enters the roots of leguminous plants, where it obtains its supply of sugars for growth, providing in return nitrogen for the requirements of the host plant, the two living in a state of perfect harmony and co-operation. Again, there are those harmful groups of bacteria which thrive in water-logged soils only, and produce compounds which are in the nature of poisons to our economic plants, and dissipate the nitrogen supply of the land. We have said nothing as yet of the fungi, the yeasts, the protozoa which consume living bacteria, and of other minute soil organisms which also play a most important part in the processes of decomposition. Indeed, many of the reactions which have been credited to the labours of the bacteria are in reality the work of these associated forms. However, sufficient has been said to indicate that the "social organisation" of the soil population is quite as complex as that of the human race. They lead a quiet existence in a state of peaceful contentment while the soil is in its normal state. True, the relative numbers of each class vary considerably with variations in local conditions; but the economy of the entire population is rudely disturbed when a lavish supply of available food is suddenly turned over to them. If it should be, for instance, an application of molasses or other highly available food, the fungi first increase in numbers at a tremendous rate, and permeate the soil mass with their downy, thread-like bodies; as suddenly, the food supply is finally consumed, and wholesale destruction of the fungi results. Their body tissues now serve as food for the several bacterial types, which are temporarily favoured by a wealth of food for energy and growth. They are, in turn, rapidly reduced in numbers when this stage of the decomposition is completed. And so through the successive stages, until finally the plant foods added in the molasses are again made available for plant nutrition, while the soil gains a residue of the difficultly decomposable substances which are produced, or remain following the decomposition, to become associated with the soil humus, and the soil population again pursues the relatively even tenor of its way.

CONCLUSION.

We must, therefore, regard the soil as a *living* system in which the minute forms of life are ever active, and the results of whose interesting reactions are of such vital importance to the farmer. They pursue their labours for twenty-four hours a day, and seven days in a week; yet they demand as their reward only the waste residues of the crop so worthless to the farmer. Surely they must be regarded as his most efficient workers, whose well-being is worthy of closer attention than is usually their lot.

An Effective Cane Beetle Trap.

By Edmund Jarvis.

ALTHOUGH the Northern canegrub may be very effectively controlled in the field by approved methods of fumigation, nevertheless this form of control involves the outlay of a very considerable expenditure. Falling values in the price of sugar render imperative the reduction of costs in all phases of the culture of sugar-cane, and consequently the attention of the entomological staff is being directed towards the development of cheaper methods of

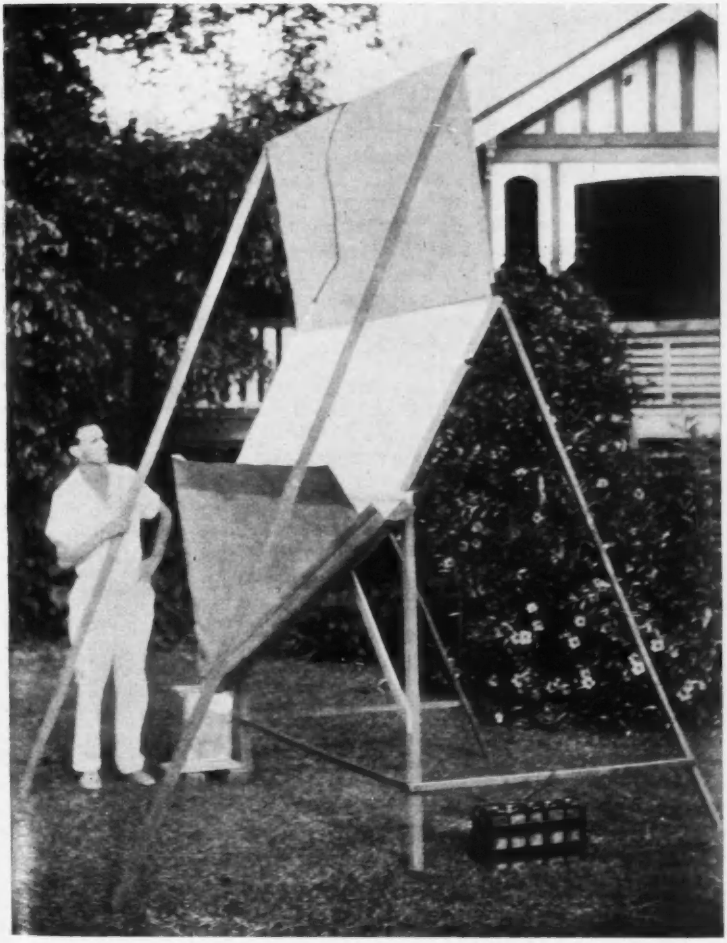


Fig. 12.

Illustrating details of construction and method of setting up the beetle trap described in this article. The outer edge of the feeding tree (a weeping fig) is shown on the left side of the photograph.

control of this pest with which to supplement the chief method of fumigation. It is the purpose of this short article to describe a simple, effective, and inexpensive light trap which has been constructed and tested under the direction of the writer. The operation of the trap is based on the well-known facts that the greyback beetles show a marked preference for certain types of feeding tree, and that both sexes of this particular beetle are attracted by artificial lights. Artificial light traps have been used to some extent in past years, and at Meringa we have frequently trapped large numbers of beetles in a couple of hours by means of a trap consisting of an oil lamp placed in front of a white linen sheet, which was suspended before a weeping fig-tree. In the operation of such traps, however, the beetles had to be collected by hand and, owing to the fact that no steps were taken to drive the beetles to the trap, the numbers collected were small in comparison to those collected by the method here described.

After emergence from the ground the beetles spend a period of about two weeks, mating and feeding on the leaves of trees, before depositing their eggs in the canefields. The favourite food plant of the greyback beetle is the weeping fig (*Ficus benjamina*), which has the added advantage of being one of the most ornamental of shade trees. Other attractive feeding trees are the Moreton Bay Ash (*Eucalyptus tesselaris*) and a large-leafed native fig-tree (*Ficus pilosa*) which is commonly found in the forest country around Cairns. For many years the writer has studied methods of raising fig-trees from both cuttings and seeds, and information regarding this matter may be obtained from the Meringa Station.

The construction of the trap, which was designed by Mr. Kenion Jarvis, is well illustrated in Fig. 12. It consists of two sheets of galvanised iron, supported on a wooden frame and inclined at a slight angle one to the other. The galvanised iron is painted white, and a light is suspended at about the centre of the junction of the two sheets; beetles flying towards the light strike against the smooth surface of the iron, are unable to gain a foothold, and slide downwards into a sloping gutter, attached to the lower end of the trap, and are shot into a kerosene tin or other receptacle from which return is made impossible. In the experiments conducted this season the source of light used was an electric bulb of about 22 candle-power, operated from a car battery.

A suitable feeding tree is selected and the trap is placed in position, facing the tree and about 15 ft. distant from it. In order to permit of the ready shaking of the branches of the tree, ropes are attached to the branches or long forked sticks are provided. The most suitable time for commencing the operation of the trap appears to be about 8 p.m., but it may be continued at intervals until as late as midnight. The light is turned on and the branches of the feeding tree are shaken. Many of the beetles are thrown to the ground while the remainder are moved to the outer twigs by the shaking; they remain motionless for a minute or so and then mount into the air and fly towards the light, dashing themselves against the iron sheets. Those which fall short of their objective excitedly crawl up grass stems, &c., and make a second flight, usually attaining their objective in the second attempt. Under suitable conditions and during periods of heavy beetle flight the beetles literally swarm to the trap. Dark nights, especially when preceded by showery or humid weather, offer ideal conditions for

the trapping of this beetle, but reasonably satisfactory trapping may be effected even on bright moonlight nights. In this connection it is interesting to note that while beetles are not ordinarily attracted to an artificial light on a bright moonlight night, nevertheless when suddenly disturbed on their feeding trees, in the manner described above, they will readily fly to a nearby light.

The following figures will give an idea of the number of beetles caught in a single trap at the Experiment Station once the beetles had commenced to emerge freely. The trap was set up in front of the feeding trees and the trees intermittently shaken over a period of about two hours.

Date.	Number of Beetles Caught.	Number of Fig Trees Treated.
24th November	1,279	3
30th November	228	1
1st December	249	1
4th December	1,426	1
5th December	9,500	3
7th December	2,912	1
13th December	10,212	3

A photograph of the pile of beetles obtained in the last trapping recorded above (13th December) is reproduced in Fig. 13. In this particular case the number of females trapped was 6,808, while the number of males was 3,404. A canegrower at Meringa, who had observed these successful experiments, had a duplicate trap constructed

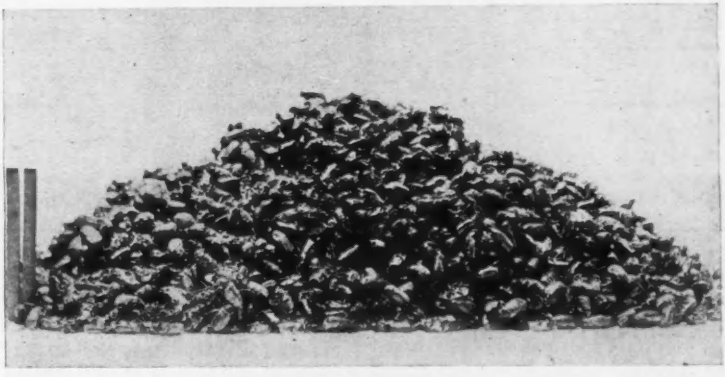


Fig. 13.

Ten thousand two hundred and twelve greyback beetles (46 lb.) caught in a single trap during 1½ hours' exposure in front of three weeping fig-trees on 13th December.

and trapped some 52,000 beetles from fig-trees adjacent to his residence. The number of beetles caught may be computed by allowing 200-220 beetles to the quart or about 3,500 to the kerosene tin.

The trap illustrated on page 117 may be inspected at the Meringa Station, where any further details regarding construction or operation may be obtained. In addition, Mr. J. H. Buzacott has constructed a portable form of this trap, and will be pleased to demonstrate it to growers.

The Value of Irrigation in Mackay.

THE value of irrigation in cane areas where the rainfall distribution is uncertain is well demonstrated by the results obtained on Mr. A. McNichol's farm during 1932-33. A small block of E.K. 28, one acre in area, was divided into two plots; one of these was irrigated, while the other was dependent entirely on rainfall. The block was planted in July, 1932, and fertilized uniformly with a normal mixed manure at the rate of 4 cwt. per acre.

In all, the irrigated plots received a watering on each of the following dates:—8th October, 1932, 9th November, 1932, 6th December, 1932, 20th March, 1933, and 12th April, 1933.

The benefits of the spring irrigations were most marked, and the unirrigated area required two cultivations with the scarifier after the irrigated cane was out of hand.

The autumn and winter rains of 1933 were decidedly favourable for sustained crop growth, and a heavy tonnage was cut from both plots. The results are as follows:—

——	Cane, Per Acre.	C.C.S. in Cane.
	Tons.	Per Cent.
Irrigated cane	57·0	13·85
Non-irrigated cane	34·4	15·1

It will be seen that the irrigation was responsible for an increase in yield equal to 22 tons of cane per acre; although a lower c.c.s. resulted with the consequent rank growth of the watered area, the cost of irrigation was entirely justified by the financial return which, based on sugar at £17 per ton, reveals an increased net income of £22 per acre in favour of the irrigated plot after allowing harvesting costs. These figures suggest the possibilities of intensive cultivation on reduced acreages as a means of rehabilitating the industry in those older areas of the State where irrigation facilities exist or could be created.

The Selection of Disease-free Cane Plants.

By W. Cottrell-Dormer.

THE control of cane diseases is best effected by the planting of resistant varieties, and some growers may say to themselves: "The variety which I propose planting is resistant to such-and-such a disease, which is the most serious in this district, so I have no need to worry." Indeed, it is one of the aims of the Bureau to find canes for the various districts which, while being highly desirable commercially, are at the same time very resistant to disease. A great deal has already been done in this respect, but it must be realised that so far no canes have been found which are resistant to all diseases in any given district, so the growers holding the view expressed above are really making a big mistake. A few illustrations will serve to support this statement: In the far North Badila still leads in popular favour; it is fairly resistant to leaf scald, but in certain areas is showing marked "deterioration" owing to chlorotic streak, a disease which was brought to the notice of growers in the last October issue of the

Fig. 14.—Leaf Scald.

Look for stunted stems, with rather bunched-up tops; shortened leaves with large whitened areas or distinct white lines with dead tips. Many side shoots are often present which possess similar leaf markings.

—Photograph by D. S. North.

"Quarterly Bulletin"; B. 147 proved a useful cane in checking the progress of gumming disease in the Mulgrave district some few years ago, but is fairly susceptible to downy mildew. In the Central districts P.O.J. 2714 has shown promise on some of the better soils and is very resistant to mosaic, but against this we find it highly susceptible to red-stripe, dwarf, leaf scald, and downy mildew. In the Southern districts P.O.J. 2878 is rapidly gaining favour on account of its high resistance to gumming disease and its suitability as an early planter and a good ratooner, but it must be watched carefully, because of its susceptibility to Fiji disease and to downy mildew; similarly, the Bureau has under propagation several other canes which, with P.O.J. 2878, will soon bring gumming completely under control, but which exhibit more or less susceptibility to those two other diseases.

Fig. 15.—Downy Mildew.

This disease is characterised by the presence of well-defined long, yellow stripes on the leaves. These stripes have irregular but sharply defined margins, and on the under side of the leaves they bear a certain amount of white fungus growth (this is shown magnified several times in the inset). At this time of year affected stems do not differ a great deal in growth from healthy ones, but during the winter months they tend to produce long thin stalks with small, badly diseased tops.

From these remarks it will be gathered that each district still has its disease problems, though in each case the more serious ones are gradually being rectified by the use of resistant canes. In each case most of those diseases which cannot yet be controlled by this means can be checked to a very considerable extent by the careful selection of healthy planting material. No cane should ever be used for plants without first of all a careful inspection from end to end of the field. Also, the practice of buying plants from distant farms for a so-called change of plants is very dangerous except under competent supervision, and generally is unnecessary. It is far safer to obtain plants from near at hand so that a personal inspection can be made before

Fig. 16.—Dwarf.

In the Mackay district a sharp look-out should be kept for small badly stunted stools, especially in P.O.J. 2714, Clark's Seedling, Malagache, E.K. 28, and P.O.J. 213. If the stunting is due to dwarf disease the leaves, especially the younger ones, will be found to be copiously marked with very fine irregular broken streaks which have a pale-green colour much lighter in shade than the remainder of the leaves. In advanced cases the heart leaves are very pale in colour and are badly frayed along their margins and at their tips.

cutting. It is not sufficient that the cane look alright as a whole, or for it to be highly resistant to such-and-such a disease; it must also stand up to that end-to-end inspection. If disease is located the endeavour should be made to find a healthy field elsewhere, because for every stool which shows disease several others will, no doubt, be present which have become infected but which do not yet show any symptoms. Where cane suitable for planting cannot be obtained free from a given disease, growers should communicate with the Bureau in order that they may be told whether any suitable resistant cane is available to take the place of the variety which they first intended planting.

These notes are written primarily for those growers who propose doing some early planting, though, of course, the same vigilance over planting material must be maintained at whatever time of year planting

Fig. 17.—Fiji Disease.

This disease resembles dwarf, in that affected stools become very badly stunted. They differ, however, in these respects: Affected leaves are not marked by fine streaks; instead they bear on their underside small elongated lumps or galls which can readily be felt with the fingers as well as being plainly visible in all but the most recently infected examples. Another point of difference from dwarf is found in the colour of the leaves of affected plants; instead of tending to become pale they assume a darker green than is normal; these leaves also become rather stiff and brittle instead of remaining soft as is the case with dwarf. Fiji disease occurs in portions of the Southern districts where it should be searched for, more particularly in all P.O.J. varieties—in D. 1135, M. 1900 Seedling, and in Uba. Although it is unlikely that Uba will be planted to any great extent during the coming season, yet old stands of this variety should be inspected, since if they contain the disease they naturally serve as a source of infection for better canes which may be planted nearby. A golden rule for Southern districts would be—search for galls on the underside of leaves of any stool which looks abnormal, regardless of the variety.

—Photograph by J. P. Martin.

may occur. Those growers who are able to make an early start with their planting, and are doing so, are to be commended; we now appeal to their common sense to make a clean start as well as an early one. The advantages of early planting are yearly becoming better recognised by growers. Thus, apart from purely agricultural benefits such as increased yield and easier weed control, early planting enables cane to resist or escape much of the infection from certain diseases. Mosaic disease is a case in point, because this disease attacks young cane more readily than cane which is well grown, and because it is transmitted from diseased to healthy stools by an aphis which reaches its greatest numbers during summer, when spring plant is still very young and many grasses are flourishing which are able to act as alternate hosts. Similarly, greater growth enables autumn or early plant cane to a great extent to resist red-stripe (top rot) which attacks principally late plant cane during the summer months. Again, early plant cane has a better chance of escaping leaf scald than late plant, because the symptoms of this disease are usually more striking in cane which has been stood over than in cane which is cut during the spring; hence it is easier to find the disease, and therefore, also to avoid using diseased crops for planting material. It will be evident, however, that unless care is taken to use none but disease-free plants much of the advantage of early planting will be lost. The time when growers will be planting their early fields will soon be with us, and it is an old but a true maxim that tells us that an ounce of prevention is worth many pounds of cure. Now is the time for those growers to make the best use of that ounce of prevention by carefully inspecting their planting material and so avoiding the losses which in many cases must inevitably accrue through disease if this precaution be not taken.

With a view to assisting growers we are reproducing with this article a number of photographs of some of the more important diseases together with instructions as to how to recognise them. It is fully realised that one cannot become expert at recognising cane diseases merely from reading articles or looking at pictures, but it is hoped that these notes may prove useful in once more emphasising to growers that if they are to keep their fields free from disease the first essential is that planting material be thoroughly inspected from end to end before being cut for plants. The following diseases should be watched out for in the various districts:—

Far North—Leaf scald, chlorotic streak,* and downy mildew;
Central districts—Leaf scald, downy mildew, and dwarf.
Southern districts—Fiji disease and downy mildew in all P.O.J. canes, and leaf scald in Mahona.

Mosaic is too well known to warrant special mention; red-stripe (top rot) cannot be controlled by plant selection, so will not be discussed here; gumming, owing to the new resistant canes, will not trouble growers to any great extent in the future, so need not be more than mentioned.

Our advice to growers is neatly expressed by that age-old injunction: "As ye sow, so also shall ye reap;" or—in other words—if you wish to harvest a healthy crop of cane, take care to use none but healthy plants.

* Note.—A fully illustrated description of chlorotic streak will be found in an article by Mr. A. F. Bell, commencing on page 42 of the "Quarterly Bulletin" (No. 2) which was issued in October last year.

Trash Conservation.

By N. J. King.

THE importance of trash conservation is being more widely recognised by progressive cane farmers in Queensland in recent years. In the less humid portions of the State, particularly Bundaberg and adjacent areas, the value of trash as a moisture-conserving mulch is not fully appreciated. Likewise, over the greater part of Queensland's cane areas, it is only in the last few years that general consideration has been given to the building up of soil humus by the consistent turning-in of cane trash. Northern farmers may not see the value of a practice which tends only to conserve soil moisture, but every farmer, even in the wet belt, will admit the necessity for saving all material likely to increase the humus content and the fertility of the soil, and improve its physical condition.

In the Bundaberg district a measure of controlled experimental work on trash conservation has been carried out, primarily to evaluate its potentialities as a mulch, the soil humus factor here being considered of minor importance. So far as experimental and actual field results have shown up to the present, trash mulching is by far the best method of conserving moisture yet evolved for cane lands. The field of investigation opened by this procedure is a large one, and drastic changes in the present method of harvesting and trash burning must be made before the adoption of this practice can become an accomplished fact. There is nothing new or revolutionary in the idea, but as the Queensland sugar soils as a unit are palpably deficient in organic matter and the Southern soils deficient in available moisture, much benefit may be gained by canegrowers in all areas by the adoption of trash conservation as a general practice.

MOISTURE CONSERVATION.

The first experiment carried out at Bundaberg was to gauge the value of a trash mulch as a means of conserving moisture, as against the usual loose soil mulch obtained by surface cultivation. Four plots were pegged out and treated as follows:—

Plot (1)—Bare fallow, surface undisturbed except to hand-pick weeds;

Plot (2)—Hoed to a depth of 2 in. to simulate a scarified surface under farm conditions;

Plot (3)—Covered entirely with a double layer of sacking to act as a mulch;

Plot (4)—Covered with a light layer of trash, equivalent to that from a 10-ton crop of cane.

Borings were made in each plot at intervals of two to three days and the moisture content of the soil determined, at intervals of 6 in., to a depth of 4 ft. Steady rain fell at the commencement of the experiment and it was found that, ten days after the termination of the rain, the first foot of soil on the bare fallow plot had lost by evaporation the equivalent of 60 points of rain more than had the trash-covered area. The plot which had been surface-hoed lost 55 points, while the area covered by sacking was in a similar condition to the trash-mulched plot.

It is therefore quite evident that, on the red volcanic soil, little benefit is derived from a shallow earth mulch in so far as moisture conservation is concerned, but that trash was instrumental in conserving further 60 points of moisture for crop growth which would normally be lost by surface evaporation. Further, costs of cultivation are entirely eliminated on the trash-covered areas.

Some further work was initiated on adjoining blocks of growing cane, one of which had a fairly heavy trash mulch and the other had a bare surface. A site was selected in each block so that the borings were only some 20 ft. apart and would be comparative. Ground levels were similar and surface and subsoil characteristics were the same in every respect. The work began in November, 1932, when ratoon growth was still slight and comparable conditions existed in the two blocks. Shading of interspaces was at the same degree of development. Borings were made in the interspaces to a depth of 4 ft. at definite time intervals depending on weather conditions, and the moisture content of each foot of soil separately determined. Some of the figures obtained are tabulated below, together with the rainfall of the period under review.

Rainfall. Period.	Points.	Date.	No Trash Area.				Trash Area.			
			0–12″	12–24″	24–36″	36–48″	0–12″	12–24″	24–36″	36–48″
Dec., 1932 : 8–12	37	7–12–32	19·3	23·6	24·8	24·9	27·1	26·7	26·4	24·3
		14–12–32	16·6	21·8	22·2	23·3	26·3	26·3	25·8	23·0
17–19	143	19–12–32	30·4	22·7	22·6	23·1	34·9	30·3	26·0	23·5
20–22	66	22–12–32	27·2	26·7	25·8	25·9	31·9	30·1	28·2	26·9
23–24	61	3–1–33	20·6	21·8	22·2	20·5	28·2	28·3	24·4	24·7
Jan., 1933 : 17–22	648	16–1–33	19·4	21·8	22·3	22·8	27·8	28·1	26·0	25·0
		23–1–33	26·8	29·3	29·5	28·0	31·3	31·8	31·0	33·6

Two major points are worthy of notice in considering the above figures. Firstly, on the 7th December, when no appreciable fall of rain had occurred since the 19th October, the average percentage of moisture in the first foot of soil underlying the trash was nearly 8 per cent. more than in the first foot of the uncovered area; and it must be remembered that this is where most of the crop roots normally feed. This is equivalent to the additional amount of available moisture which would follow a fall of 120 points of rain. Secondly, after a heavy fall of rain prior to the 19th January, the trash-covered block showed a more rapid percolation of moisture to the lower levels than did the bare section. This more rapid seepage during rain can only be due to the absence of hard pans as a result of not having used so many cultivation implements, the lack of soil packing by rains, and the improved physical condition of the soil consequent upon a programme of trash conservation. This latter feature is also reflected in the improved moisture-holding capacity of the trash-mulched soil.

TRASH AS A PREVENTIVE OF SOIL EROSION.

In North Queensland, and even in the drier South, the incidence of heavy falls of rain during the summer and early autumn months is frequent. Soil tilth obtained after much labour with cultivation implements is frequently destroyed by the beating action of a heavy downpour; scouring and washaways occur on lands with even a slight slope, and surface cultivation after rain to destroy weeds and break up the surface crust helps to form cultivation pans to the detriment of root development and moisture penetration. These disadvantageous factors are minimised by trash mulches. Obviously rain cannot beat down a soil surface which is covered by a heavy layer of trash; the mechanical action of the trash in preventing rapid flow of surface water lessens the risk of scouring; surface cultivation to destroy weeds or form soil mulches is rendered unnecessary by the presence of a good trash cover and the fact that this cover prevents the growth of most weeds. The principal reason for run-off and scouring under heavy rainfall is that the soil is unable to absorb the rain as rapidly as it falls. Deep cultivation and good tilth assist rapid absorption, and the absence of hard pans increases the absorptive rate of the subsoil. Where cultivation or plough pans exist, an almost impermeable barrier is offered to the penetration of moisture. Provided that subsoiling or deep grubbing followed ploughing in the preparation of the land for planting, no plough pan should exist in the soil at ratooning. Therefore a trash layer on the soil when ratoons are "coming away" obviates the necessity for surface cultivation implements on such blocks, and the percolation rate of moisture in the soil is higher under the trash than with a bare surface which needs constant scarification.

SOIL ORGANIC MATTER.

The sugar-cane soils of Queensland are notoriously deficient in organic matter. Soil humus or organic matter decomposes most rapidly under conditions of high rainfall and high temperature, and consequently soils within the tropical zone are generally deficient in this important ingredient. Organic matter in the soil in the form of humus not only improves soil tilth, but increases the moisture-holding capacity of the soil to a marked degree, and is intimately related to the fertility of the land. Samples of the virgin volcanic soil in Bundaberg and the adjacent farmed soil gave on analysis the following interesting figures:—

Soil.	Total Carbon.	Organic Matter.	Total Nitrogen.	Moisture Holding Capacity.*
	Per cent.	Per cent.	Per cent.	Per cent.
Virgin red volcanic loam	4·5	7·8	·478	70
Adjacent cultivated soil	2·1	3·6	·220	54

The largest potential humus producer on a cane farm is cane trash, yet this is nearly always burnt either before or after cutting the cane. Farmers endeavour to increase the humus content of the soil by growing

* The moisture-holding capacity of the soil is really a measure of its "pore space." It is generally found that the "field capacity" of a soil—that is, its moisture content when thoroughly drained and free from excess water—is approximately equal to one-half its moisture-holding capacity.

green manure crops during each fallow period and turning these into the soil for decomposition. Assuming that the average green crop is 10 tons per acre and that the farmer grows a plant and two ratoon crops from each planting of cane, he therefore turns in the equivalent of 2½ tons per acre of green manure for each year in the rotation. During the past year some work was carried out to find the ratio of green leaf to millable cane with a selection of varieties. The figure varies with the variety grown and with the rate of growth of the crop, but an average figure would be about 80 per cent. That is, for every 100 tons of cane, 80 tons of green leaf are produced. Therefore, from a 25-ton crop of cane, some 20 tons of green trash and tops are available for increasing soil organic matter. So that if the grower so desired he could conserve each year on a 25-ton crop of cane some 20 tons per acre of "green" trash, whereas as shown above the rotational green manure crop gives only an average of 2½ tons per year of green material.

The green manure crop admittedly yields a considerable quantity of additional nitrogen to the soil; but the trash, though only returning to the soil nitrogen which it has assimilated therefrom, is returning a supply of this plantfood which is otherwise lost in the atmosphere during the pernicious practice of burning. The following figures are of interest in the light of the above statement:—

Source of Organic Matter.	Green Matter.	Dry Matter.	Nitrogen.
	Tons.	Tons.	Lb.
Poona pea, 10 tons per acre	10	2	118
Trash over 3 years from 25-ton average crops of cane	60	15	107·5

METHODS OF DEALING WITH TRASH.

Little experience is available in Queensland to decide which is the best method of dealing with the trash on ratoon fields. Three methods suggest themselves, namely: (1) Volunteer ratooning, whereby the ratoons are allowed to grow through the trash layer; (2) relieving from the cane rows; and (3) raking the trash into every second interspace. Each method has certain advantages to commend it, but the writer has decided to discuss the third method on account of its more universal adaptability.

In this method of trash-raking or trash-rolling into alternate "rows" the trash is cleared from one interspace and piled on to that in the adjacent interspace. The finished field presents the appearance of alternate trash-covered and bare strips. The bare interspaces are cultivated as usual with ratooning implements, whereas no cultivation is carried out on the trash-covered sections. Obviously cultivation costs are halved. Fertilization can still be carried out on one side of each cane row, and no valuable farming practice is sacrificed by having the trash in this position. The only problems arising are:—(1) A cheap and effectual method of raking the trash; and (2) an efficient method of turning in the trash when the stubble is finally ploughed out.

RAKING THE TRASH.

Those farmers who in the past have been dealing with trash by this method have adopted as a rule the costly and laborious practice of hand-rolling. One plantation manager in South Queensland has simplified the practice somewhat by inducing his cutters to work up one row of cane and down the next, and thus leave the major portion of the trash and tops in alternate interspaces. This operation reduced raking costs considerably. It is evident, however, that to make trash-raking more popular an implement would have to be introduced which would do the work cheaply and efficiently.

Fig. 18.—Side-delivery Rake Commencing the Operation of Trash-rolling.

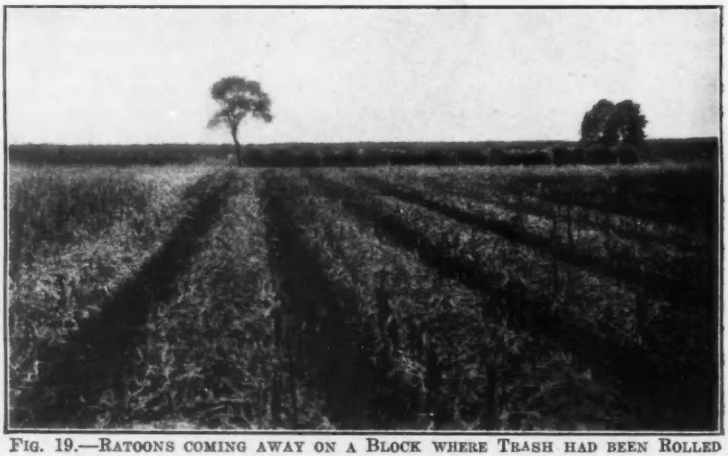


Fig. 19.—Ratoons coming away on a Block where Trash had been Rolled by the Side-delivery Rake.

During 1933 the Bureau obtained a side-delivery rake for trial and experimental purposes. Sufficient teeth were removed from the rake so as to make it work on a 4 ft. 6 in. interspace, though the implement can be made to operate on any width up to 6 ft. 6 in. Excellent work was done on the trash from crops ranging from 10 to 30 tons per acre, and on the latter crop three rows of trash were successfully rolled into one, a very neat job resulting therefrom. The trash from a 40-ton crop of D. 1135 was also rolled with success, the treatments, three into one and five into one, being easily effected by the implement. As the rake is capable of dealing with from 8 to 10 acres a day, the cost of the work is about 2s. 6d. per acre.

PLOUGHING-IN OF TRASH.

The trash and tops from crops of cane up to 30 tons per acre can be efficiently ploughed under by means of a single-disc plough at the same time as the old stools are being ploughed out. Any plough free from obstructions is suitable, provided the setting of the disc is adjusted by raising it to an almost perpendicular position and by keeping the disc-edge keen. For larger crops perhaps the most successful method is that evolved by a Burdekin grower. This farmer uses a single-disc plough fitted with a 28-in. disc having a well-pronounced "dish." Two discs are kept in operation, only a half-day's work being given to each before resharpening. It is important for this method that the discs be drawn out to a keen edge and always kept sharp. The disc is carefully set and the plough drawn by four young horses. Attached to the draw-bar is a length of spring steel, the free end of which presses down on the trash immediately in front of the disc, thus allowing the trash to be cut and preventing dragging by the implement. The field is worked in lands, and the first cut is made up the centre of a line of stools. The speed of the plough cuts away half the stool and broadcasts the soil across the interspace, thus covering a good deal of the trash. The second round cuts the remainder of the stool and succeeds in completely covering the remaining trash. The interspaces are thus not touched at all in the ploughing-out of stools. The field is then rolled, seeded with a green manure crop, the seed harrowed in with disc harrows, and at the correct period of its growth turned in on top of the trash.

The decomposition of trash in the soil, even under conditions of high temperature and optimum moisture, is essentially slow. This is explained by the low percentage of nitrogen and phosphate in the trash, not sufficient being available for the rapid development of those soil fungi and bacteria which carry out the decomposition. After the turning-in of a green manure crop, however, with its high nitrogen content, rotting of both trash and green manure proceeds rapidly, and within a short time little evidence remains of the large bulk of material which was incorporated with the soil.

In conclusion it should be stressed that the ploughing under of plant cane trash in ratoon fields is a practice which must be strongly discouraged. The addition of a mass of undecomposed organic matter to the soil results in a rapid depletion of the moisture supply while the rotting progresses, and this reacts most seriously on the ratoon crop in a dry spring. Further, available plantfoods are absorbed from the soil by the micro-organisms which effect the decomposition, and again the growing crop suffers. It may safely be stated that many growers who are prejudiced against trash conservation base their objections on the unfavourable results of trial fields treated in this manner.

SUMMARY.

The practice of trash conservation is one which should commend itself for the serious consideration of all canegrowers. It enables cultivation costs to be reduced, and is remarkably efficient in conserving soil moisture when employed as a soil mulch.

When ultimately incorporated with the soil it provides a most valuable source of raw material for humus production, and helps very materially in the building-up of permanent soil fertility.

By the use of the side-delivery rake during the past season it was demonstrated that the "rolling" of trash may be effected simply and economically: the adoption of this implement can be confidently recommended to all interested canegrowers. Its advantages are only too apparent in a season such as that of 1933 when it was frequently impossible to burn trash owing to the excessive wet weather experienced in all areas. Trash-rolling enables the ratoons to get away to a good start under favourable conditions, and obviates the setback which the young shoots receive from a late burn-off.

Fiji Disease Outbreak.

A FRESH outbreak of Fiji disease was recorded in the Bundaberg district at the end of last year; this outbreak occurred in the Kalkie district, and a light degree of infection has been found on five farms in that area. Owing to the high susceptibility to Fiji disease of some of the new vigorous canes which are now being propagated, every effort must be made to stamp out this disease. Officers of the Bureau are making regular inspections of the farms, and in addition, a proclamation has been issued prohibiting the removal of sugar-cane from a quarantine area, the boundaries of which are as follows:—

"The area of land bounded by the 'Back Ashfield road on the south, the Ashfield road, and thence a line drawn in continuation to the Burnett River on the east, the Burnett River on the north, and the boundary of the City of Bundaberg on the west.' "

Concession Freight Rates.

Following on the announcement in the "Quarterly Bulletin" of October, 1933, with respect to cane samples for test purposes, it is our pleasure to advise that the Commissioner for Railways has now agreed to transport such consignments of cane samples at a flat rate of 1s. per bundle.

History of the Queensland Sugar Industry.

In 1933 the Bureau issued a most valuable compilation of historical matter relating to the Sugar Industry, which was collected and prepared by the late Director, Mr. Harry T. Easterby. A limited number of volumes of this publication—"The Queensland Sugar Industry"—are still available for distribution, and a copy will be forwarded free to any canegrower making application for same to the Director.

Some Factors Influencing the Sugar Content of Cane.

By H. W. Kerr.

THE steady decline in sugar values which has been experienced over the past decade has made it imperative that growers reduce their costs of production in order that they may continue to produce crops economically. The value of fertilizers as an important aid in this respect has been stressed repeatedly, and the farm plot trials harvested during the past season under the supervision of the Bureau lend further support to this contention. The average increase in yield for thirty-nine trials was 7·2 tons of cane per acre. It is now generally agreed that heavy fertilizer applications are essential if the productivity of our cane soils is to be maintained, but the question is frequently raised as to whether the use of artificial manures acts adversely on the sugar content of the crop, so that much of the gain derived from increased crops is offset by reduced values per ton of cane.

This aspect of the problem is a most important one, particularly when sugar values reach the low levels experienced for the 1933-1934 crop. The latest estimates show that the price payable for No. 1 pool sugar will be in the neighbourhood of £17 per ton. On this basis the value of a ton of cane is approximately as follows (Central and Southern districts) :—

	s.	*d.*
12 per cent. c.c.s.	25	9
13 per cent. c.c.s.	28	10
14 per cent. c.c.s.	31	11
15 per cent. c.c.s.	35	0
16 per cent. c.c.s.	38	1

Having regard for the fact that certain fixed changes in crop production are incurred irrespective of yield or sugar content, the harvesting of the crop at maximum c.c.s. becomes increasingly important, and any practices which operate adversely must be carefully reviewed.

In preparing the results of our farm trials a statement of costs and financial return is always presented, and it is found in general that at least one treatment has proved profitable; and these calculations necessarily involve the c.c.s. of the canes from the respective treatments. However, as the results of over one hundred trials are now available, it was thought that a general review of all returns might yield interesting information on several factors which have a bearing on the problem. These will now be discussed in detail.

GENERAL INFLUENCE OF FERTILIZERS.

It is well recognised that the individual constituents of a mixed fertilizer exhibit their own peculiar characteristics in so far as they influence the sugar content of the crop. *Nitrogen*, particularly when applied in heavy dressings, certainly depresses the c.c.s. of the cane, as

is demonstrated by the following results from a trial harvested in the Burdekin area recently:—

Sulphate of Ammonia per Acre.	Cane per Acre.	C.C.S. in Cane.
	Tons.	Per cent.
100 lb.	42·6	17·4
200 lb.	49·5	16·7
300 lb.	51·5	16·4
400 lb.	52·4	16·1
500 lb.	55·8	15·4

Doubtless these results are rather exceptional in the magnitude of the fertilizer influence, and are further complicated by lodging in the heaviest crops; but they show how excessive nitrogen will at least delay maturity, and, as will be observed later, reduce the final c.c.s. return when the crop is mature.*

The effect of *phosphate* on maturity has not received much attention, and it would appear that its influence is slight.

As regards *potash*, it is repeatedly asserted that crops rich in carbohydrates (sugars and starches) demand an abundance of available potash for their maximum development, and soil deficiencies with respect to this plantfood result in a reduced carbohydrate content of the crop. Further, it is generally stated that soils rich in potash produce crops which mature earlier than those not so favoured.

Considering now the results of the trials which have been harvested during the past four years, we find the following mean c.c.s. values:—

Treatment.	*Mean C.C.S.*
No fertilizer	15·48 per cent.
N P	15·19 per cent.
N K	15·32 per cent.
N P K	15·26 per cent.

The fourth treatment (N P K) is represented by those plots receiving a complete mixture: the N P plots receive no potash, and the N K plots no phosphate. From these values—representing 103 separate experiments, embracing all cane areas with crops of all ages and varieties, both plant and ratoon—it must be concluded that fertilizers do exert a slight though definite depressing influence on the c.c.s. of the cane. If we attempt to analyse these results and determine the relative influence of each individual plantfood, we find the following:—

Nitrogen (N)	Decrease: 0·23 unit;
Phosphate (P)	Decrease: 0·06 unit;
Potash (K)	Increase: 0·07 unit.

* This distinction must be noted carefully: a fertilizer *may* cause a marked diminution in the sugar content of the cane, if the crop be harvested early in the season, due to the *delayed maturity* factor: if the cane be allowed to attain *full maturity* before harvesting, the nett influence may become insignificantly small.

It is thus clear that nitrogen (sulphate of ammonia) exerts the greatest influence on c.c.s. On the average the reduction is almost a quarter of a unit. Superphosphate also effects a further slight depression (0·06 unit), and the cane from the N P plots gives the lowest returns of all. Potash, on the contrary, is responsible for a definite slight improvement in the sugar content of the juice. These results bear out the generally accepted conclusions which were outlined in the introduction to this discussion.

In our more recent qualitative trials a further treatment—P K—was included in addition to the four already discussed. It might be anticipated that the increased c.c.s. value due to the potash in this treatment would offset the depressing effect of the superphosphate, so that we would expect little difference between the P K returns and those from the check plots. The mean of sixty-three such comparisons shows—

Check	15·26 per cent.
P K	15·28 per cent.

These results suggest that the P K treatment might be preferable to the N P K in so far as it eliminates the depressing effect of the nitrogen; but when it is remembered that, on the average, sulphate of ammonia exhibits the greatest influence in crop increase—particularly with ratoons—this practice would be most unsound. However, where the nitrogen supply is provided in the form of a good green manure crop, ploughed under prior to the plant cane, the P K mixture is definitely to be recommended. Our trials have shown repeatedly that extra nitrogen is without much influence on yield under these conditions, and would serve only to depress the c.c.s. or delay the maturity of the crop.

As an average of sixty-three trials, the relative yield increases to N, P, and K were as follows:—

Increases due to—	*Tons.*
Nitrogen	3·7
Phosphoric acid	2·3
Potash	1·8
Total	7·8

It will be understood, of course, that the respective applications of the three plantfoods bore no relationship to one another, and these results are to be regarded purely from the qualitative aspect.

INFLUENCE OF TIME OF HARVESTING.

It would naturally be expected that the adverse effects of fertilizer on sugar content would be most serious early in the season. The above results have therefore been reclassified on the basis of the time of harvesting; in order to subdivide the results into relatively equal groups, the season was considered in four periods: (1) June-August; (2)

September; (3) October; (4) November-December. The average c.c.s. values of the several groups are as follows:—

Harvesting Period.	No. of Trials.	Average Age of Crop.	C.C.S. Values.			
			C	NP	NK	NPK
		Months.	Per cent.	Per cent.	Per cent.	Per cent.
June–August	23	12·8	15·05	14·67	14·67	14·52
September	22	13·7	15·43	15·18	15·33	15·32
October	36	14·4	15·93	15·71	15·86	15·81
November–December ..	22	14·6	14·98	14·65	14·84	14·83

The results are brought out more clearly when represented graphically (Fig. 20)—

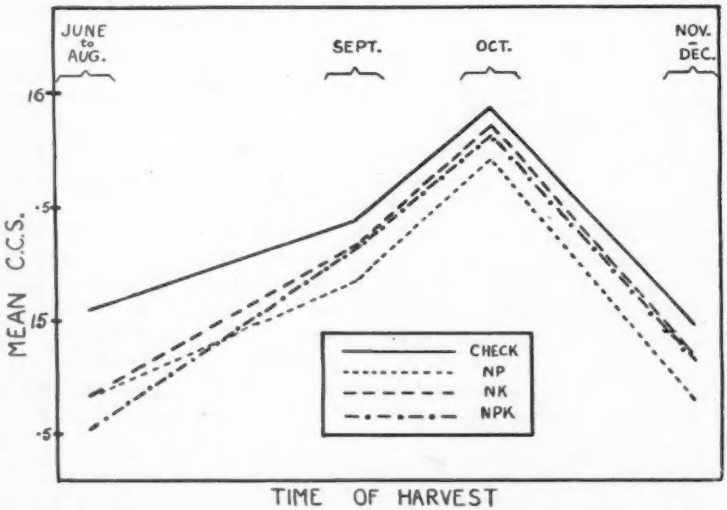


FIG. 20.—GRAPHICAL REPRESENTATION OF EFFECTS OF FERTILIZATION UPON PERIOD OF MATURITY OF CANE CROPS.

It is evident that in the early stages of the harvesting season the adverse influence of fertilizer is most profound. From September to December the reduction in c.c.s. is considerably diminished, and in the case of the NK and NPK plots becomes relatively insignificant (mean — 0·11 per cent.). The extent of the reduction at each period is as follows:—

——	June–Aug.	Sept.	Oct.	Nov.–Dec.	All Plots.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
C—NP	0·38	0·25	0·22	0·33	0·29
C—NK	0·38	0·10	0·07	0·14	0·16
C—NPK	0·53	0·11	0·12	0·15	0·22
No. of Plots	23	22	36	22	103

In the early part of the season the N P K plots showed the lowest c.c.s. values, but from September to December the cane from the N P treatment was characteristically poorest in sugar. Certainly the mean difference between the N P K and N P treatments was only 0·14 units over this period, resulting in a reduced value of about 5d. per ton of cane; but it is of interest in that it demonstrates to those growers on the alluvial soils of North Queensland who persist in the application of superphosphate and sulphate of ammonia only in preference to a complete mixture, that the added potash is of distinct value in promoting higher c.c.s. returns. Though the increased crop yield due to 100 lb. potash per acre may be only from 0·5 to 1·0 ton of cane, the combination of this gain with the improved sugar content makes the practice profitable.

Where potash is consistently omitted from the fertilizer programme, this plantfood may eventually become a factor seriously limiting crop growth; and where this condition obtains the deficiency in available potash has a greatly exaggerated effect on c.c.s. This is clearly demonstrated by the following returns which represent the means from thirty-two experiments on which quite definite response to potash was recorded:—

Treatment.	*C.C.S.*
No fertilizer	15·27 per cent.
N P	14·95 per cent.
N P K	15·18 per cent.

Here it is observed that potash results in an improved c.c.s. yield of 0·23 unit on an average, and the returns from the N P K plots are but slightly inferior to those from the plots receiving no fertilizer, in spite of considerably improved crop growth.

The red volcanic soils of the Queensland cane areas are notably deficient in available potash, and on certain trials located on this soil type increased yields of 12 tons of cane per acre have been recorded. In such cases the c.c.s. values of the cane fertilized with potash have actually shown an improvement of a full unit over those plots receiving no potash. Canes from these soils are usually characterised by their low sugar content, and it is confidently suggested that consistent heavy applications of this plantfood—potash—will result in a permanent marked improvement in this respect.

With regard to the influence of potash in accelerating maturity, little can be deduced from the results at present available. Certain isolated trials suggest this possibility, but the summarised values show only a general overall improvement in final c.c.s. The situation becomes obscured by certain late-harvested crops which were cut at over-maturity. Here any accelerated maturity effects due to potash have actually resulted in a *lower* c.c.s., and in taking a general average of all plots, this would neutralise any benefits experienced earlier in the year.

TIME OF FERTILIZER APPLICATION.

The time at which fertilizer is applied has a very definite bearing on the final c.c.s. of the crop. This is particularly true with regard to applications of sulphate of ammonia, and growers should aim at completing their fertilizer dressings as far as practicable by the end of December. In the farm trials here discussed this practice has been

followed, but results obtained elsewhere show that the depressed c.c.s. values due to the use of fertilizers would be considerably greater than those recorded herewith had the fertilizer dressings been delayed.

AGE OF CROP.

An interesting comparison is obtained by grouping the returns according to the age of the crop. In order to subdivide the complete set of values into two approximately equal groups, canes up to fourteen months old are compared with those over fourteen months. The values are as follows:—

Treatment.	Under 14 Months (47 Trials).	Over 14 Months (52 Trials).
	Per cent.	Per cent.
C	15·08	15·92
N P	14·81	15·59
N K	14·89	15·75
N P K	14·84	15·73
Mean	14·91	15·75
Average age of crop	12·3 months	15·3 months

The influence of the age of the crop on c.c.s. is most striking, and offers a further good reason in support of "early" planting as against spring planting in those areas where it is at all possible. In addition to the added crop yield—probably from 3 to 5 tons per acre—each ton of early plant cane possesses a value more than 2s. higher than the spring plant crop, if we are justified in using the above average figure (0·84 unit). The average difference in age between the above classes was only three months.

Of course, the factor of age must not be considered alone in this regard, for it is well recognised that the c.c.s. value of any crop improves to the point where the cane is fully mature, after which it falls off due to over-maturity; but, other things being equal, early growth means higher c.c.s. values, while late crop growth operates against normal maturity. This is very clearly demonstrated by the c.c.s. values recorded in most areas during the 1933-1934 harvest.

PLANT v. RATOON CANE.

In comparing the relative c.c.s. values for plant and ratoon canes, the factor of age of crop again enters; the respective average figures are as follows:—

Treatment.	Plant Cane (60 Trials).	Ratoon Cane (39 Trials).
	Per cent.	Per cent.
C	15·66	15·28
N P	15·38	14·92
N K	15·43	15·18
N P K	15·42	15·06
Mean	15·47	15·11
Average age of crop	14·7 months	12·4 months

The comparative influences of the individual plantfoods are sensibly the same for both classes of cane. The average c.c.s. for all treatments is 0·36 unit higher for the plant crop, but if we compare this value with the difference shown on p. 138 (0·84), it is suggestive that, on the basis of equal age, ratoons will show a somewhat higher c.c.s. value than plant cane. This is indeed to be expected when it is remembered that the plantfood supply of the soil is much more abundant for plant cane than for the succeeding ratoons. This is particularly true in the case of available nitrogen, the plantfood which is responsible for the greatest influence on c.c.s.

SUMMARY.

The results of over 100 farm fertility trials harvested by the Bureau during the past four years provide some interesting evidence on a number of points affecting the sugar content of the crop. It is found that fertilizers definitely effect a slight reduction in the c.c.s. at maturity: this is due almost entirely to the added nitrogen; superphosphate is responsible for a further slight reduction, while potash definitely favours higher c.c.s. values. On soils notably deficient in potash, the influence of this plantfood becomes most marked and increases in sugar content equal to a full unit of c.c.s. have been recorded.

Other factors bearing on this problem are the age of the crop at harvesting, the period of the year at which the cane is cut, and the nature of the cane, *i.e.*, plant or ratoon. Although the data are not sufficient to permit of any but broad deductions to be made, there is no doubt that the results demonstrate very clearly several avenues along which growers may work in order to improve their returns.

Some Notes on the Soils of the North Queensland Sugar Areas.

By G. Bates.

THE cane soils of North Queensland may be classified into four main groups:—

	Proportion of Total Area. Per Cent.
(1) Alluvial soils—	
(a) Granitic	} 36
(b) Schist	
(c) Mixed	
(2) Schist soils	35
(3) Red volcanic soils	15
(4) Gravel soils	14

The distribution of the main soil groups is shown in the sketch maps which form an Appendix to this paper. The data from which these maps were constructed were secured in the course of a preliminary survey carried out by N. J. King in 1930.

The general characteristics of these soils and their behaviour under cultivation are briefly as follows:—

(1) ALLUVIAL SOILS.

These form the most important soil class and for purpose of discussion must be divided on the basis of the parent rock from which they are formed, into (*a*) Granitic, (*b*) Schist, and (*c*) Mixed.

(*a*) Granitic Alluvials.

These constitute the major portion of the alluvials and are generally soils of a more or less heavy nature which require careful working to maintain a good tilth. In this area of high rainfall the general tendency is to work these soils when in a too moist state, which destroys the physical structure and causes the formation of hard lumps. They are prone to form hardpans, and it has been proved that subsoiling is a beneficial practice. Many of our alluvials also require draining. They are almost exclusively acid with a pH (in KCl suspension) ranging from 3·8 to 4·5, so that liming is very necessary and should be a general practice.

Chemical analysis shows the potash content to be from fair to very good, phosphate from low to very low, with the nitrogen varying according to the age of the soil. Plot experiments have shown the value of liming. On a farm on the Russell River flats, a dressing of 1½ tons of burnt lime per acre showed an increase of 5·7 tons of cane in the plant crop and a further 2·7 tons in the first ratoons, an increase over two crops of 8·4 tons of cane. Similar results have been obtained repeatedly on the South Johnstone Experiment Station. A series of fertilizer trials shows that potash gives little results, while phosphates and sulphate of ammonia are responsible for large crop increases. On the basis of the results of fertilizer trials to date the Bureau recommends the following fertilizer:—

For Plant Cane—A mixture of 500 lb. superphosphate plus 100 lb. of potash in the drill when planting followed by a top dressing of 150 to 300 lb. of ammonium sulphate according as the land has been under green crop or bare fallow.

For Ratoons.—A mixture of 100 lb. sulphate of ammonia, 500 lb. superphosphate and 100 lb. potash per acre at ratooning, followed by from 300 to 500 lb. of sulphate of ammonia applied in two top dressings.

The recent alluvial soils characteristic of the low river flats constitute some of the richer soils of North Queensland. They are usually silty rather than clayey, are readily cultivated, and benefit chiefly from applications of nitrogenous manures. Except in their virgin state, they produce crops notably high in c.c.s.

(*b*) Schist Alluvials.

The schist alluvials vary in plantfood requirements as do the residual schists. Broadly speaking, all three major plantfoods seem to be required, nitrogen being the most important, followed by potash and then phosphates. These soils generally show a slight acid reaction and usually require only light application of lime.

(*c*) Mixed Alluvials.

These naturally vary widely, ranging from sandy soils to heavy clay loams. They vary considerably in plantfood requirements, because of their mixed origin, and it is not possible to generalise regarding their behaviour.

(2) SCHIST SOILS.

The cultivated area embraced by the schist soils is almost equal to that of the alluvials. They are of a residual nature, and often contain a large proportion of stones. They are generally second-class soils,

being deficient in plantfood and of particularly poor moisture-holding capacity. An extreme case of this is seen in the talc schists in certain portions of Mossman. The lime requirements of these soils vary. Some require lime, other do not.

The particular problem facing farmers on these soils is not so much a matter of plantfood, as this can be supplied as fertilizer; but lack of moisture in the spring exercises an adverse influence on crop growth. Our ratooning time coincides with the driest months of the year, and the general practice of "ploughing away" does not help matters. A narrow strip of land carrying the stools is left exposed to the drying action of sun and wind, and dry soil is scarified back to fill the furrow. If, as often happens, the weather conditions continue dry, the cane receives a check in growth and the resultant crop is disappointing, irrespective of the amount of fertilizer applied. Cultivation of these soils should aim at conserving moisture, and in this connection the conservation of trash is very helpful. Our fertilizer trials show that these soils vary considerably in their responses. Sometimes there is a large increase to phosphates, while at other times potash gives results. Without exception, however, all show a marked increase from nitrogenous manures.

On W. Chapman's farm at Hambledon, which is located on typical schist country, nitrogen gave results as set out hereunder, following an annual application of 400 lb. of ammonium sulphate per acre:—

Plant Cane.—An increase of 5·7 tons per acre (following a poor green manure crop).

First Ratoons.—An increase of 12·7 tons per acre.

Second Ratoons.—An increase of 10·0 tons per acre.

Thus, for three crops, the extra yield amounted to 28·4 tons per acre. Where phosphate and potash were applied without nitrogen the crop was practically a failure, being only 2 tons per acre better than the unfertilized plots.

On the basis of present information the Bureau recommends as fertilizer 300 lb. superphosphate plus 150 lb. of potash per acre, followed by two dressing of ammonia each of 200 lb. per acre. Old ratoons would probably profit from heavier dressings of sulphate of ammonia.

(3) RED VOLCANIC SOILS.

Farmers are in the habit of referring to all red soils as volcanic, and it is at times difficult to draw a dividing line between the true volcanics and other types. In portions of South Johnstone the red volcanic frequently overlies and merges into the red schist, giving rise to a mixed soil which is hard to distinguish from the true volcanic. The true volcanic type may be seen at Green Hill, portions of Little Mulgrave, Bartle Frere, Daradgee, and South Johnstone. These soils are very easy to work, being light and friable, and can be cultivated successfully soon after rain. They are less troubled with weeds than other soil types, possibly because the surface soil becomes so rapidly dry and heated that the grass and weed seeds will not germinate. Volcanic country is mostly undulating and the soils well drained. They show only a slightly acid reaction so that applications of lime are rarely needed. Without exception, the volcanic soils show a marked deficiency in potash, and field experiments have resulted in as great as 11 tons

per acre crop increase, from a dressing of 300 lb. per acre of muriate of potash. The application of phosphates gives but slight increases.

Further experiments to determine the optimum amount of potash required are being carried out. Plant cane on one trial showed progressively profitable increases up to 400 lb. per acre. This experiment is not yet completed and will be carried on to the third ratoons. The fertilizer recommended for this particular soil type is a mixture of equal parts of meatworks and potash, applied at the rate of 400-600 lb. per acre and followed by top dressing of ammonium sulphate.

(4) GRAVEL SOILS.

These soils embrace some of our poorest lands and are all seriously lacking in plantfood. They constitute, in the main, the "skeleton" of coarse quartz particles which remains when the fine particles formed in the disintegration of the granitic rocks of the area have been washed out by the heavy rains. They frequently show a very acid reaction when liming is a necessity. Their open texture renders cultivation easy and the chief problem is that of maintaining the fertility of the land. Where the correct fertilizers are applied good crops result.

These gravels produce large crops when first cleared, but soon show signs of plantfood deficiency. Evidence of this can be seen in portions of the Babinda area, where it was apparently the practice to rely on the alleged richness of the soils of North Queensland to produce the crop. These soils are now so depleted that they produce very poor crops. In the Tully area, where gravels form about 25 per cent. of the cultivated land, this falling off in crop yield is not so noticeable, as most of the land has been fertilized from the virgin state.

In the Tully area a piece of land was selected as an experimental block, that has just been stumped and brought under the plough for the first time. The results of this trial, which gives some idea of the rapid falling off in crop where fertilizer is not applied, are as follows:—

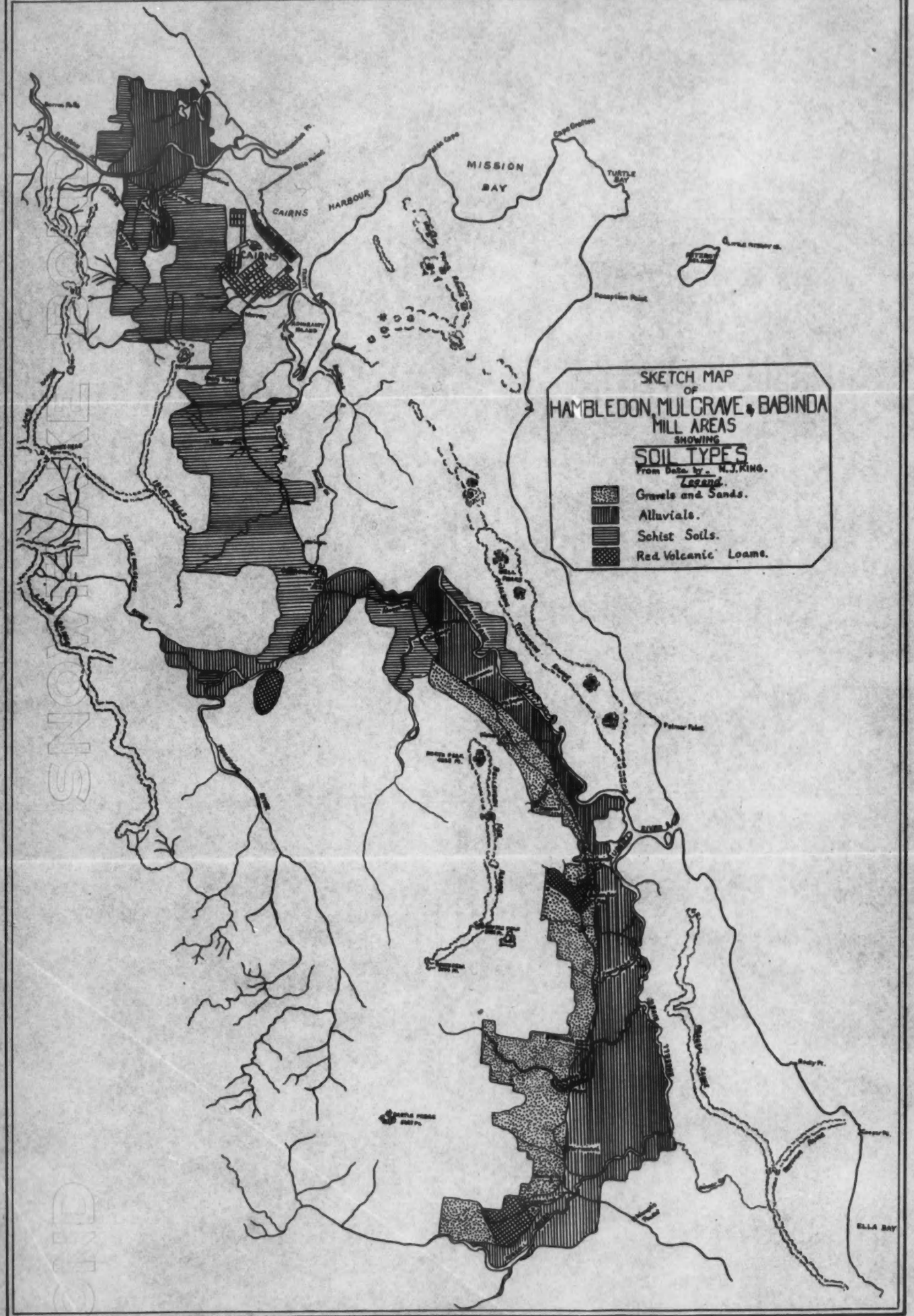
Treatment.	Plant Crop.	First Ratoons.	Second Ratoons.
	Tons.	Tons.	Tons.
No fertilizer	39·6	34·5	24·8
Complete mixture	43·1	44·2	37·5
Increase due to fertilizer	**3.5**	**9.7**	**12.7**

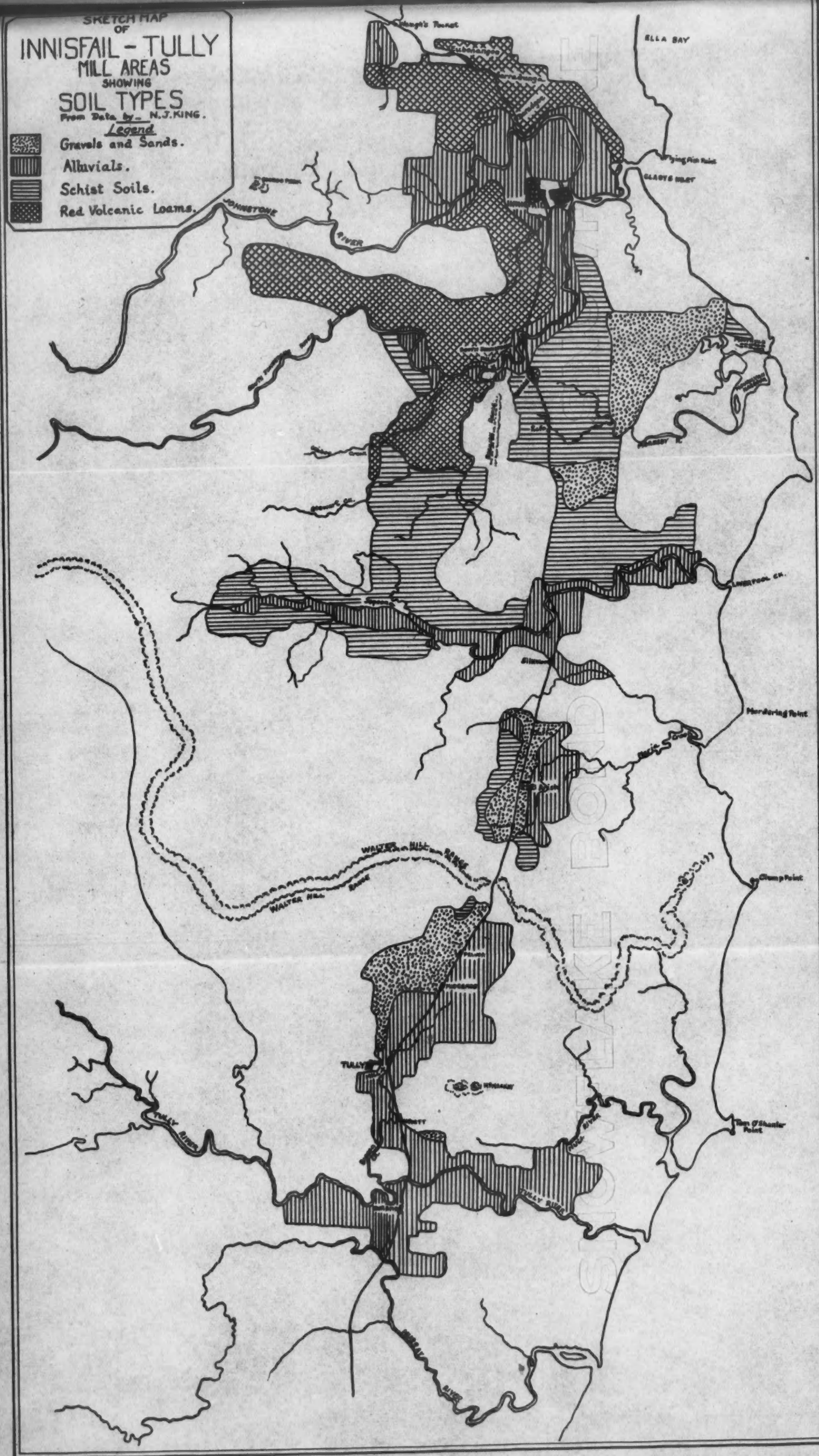
The gravel soils are particularly deficient in humus and consequently deficient in nitrogen; so that heavy dressings of nitrogenous fertilizers are required. In an experiment at Tully a dressing of 400 lb. per acre of ammonium sulphate showed an increase of 2·6 tons per acre over a dressing of 200 lb.—and this on land that was brought under the plough for the first time two years previously.

These soils are also deficient in phosphates, and superphosphate has given increases throughout all our experiments. Potash gives but little results except as it influences the c.c.s. value of the crop. The fertilizer recommended for this particular soil type is 400 lb. superphosphate plus 100 lb. muriate of potash per acre as a drill application, followed by 400 lb. of ammonia per acre in two top dressings.

David Whyte, Acting Government Printer, Brisbane.

V
1
4
A


MISSION BAY
TURTLE BAY
CAIRNS HARBOUR
CAIRNS
Palmer Point
ELLA BAY
SKETCH MAP
OF
HAMBLEDON, MULGRAVE & BABINDA
MILL AREAS
SHOWING
SOIL TYPES
From Data by. H.J. KING.
Legend.
Gravels and Sands.
Alluvials.
Schist Soils.
Red Volcanic Loams.


SKETCH MAP
OF
INNISFAIL - TULLY
MILL AREAS
SHOWING
SOIL TYPES
From Data by - N.J. KING.
Legend
Gravels and Sands.
Alluvials.
Schist Soils.
Red Volcanic Loams.
ELLA BAY
JOHNSTONE RIVER
WALTER HILL RANGE
WALTER HILL CREEK
TULLY RIVER
MURRAY RIVER
Mourilyan Harbour
Clump Point
Dunk Island